Gross-alpha and gross-beta measurements.

Critical remarks and a better alternative

LSC approach

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Introduction

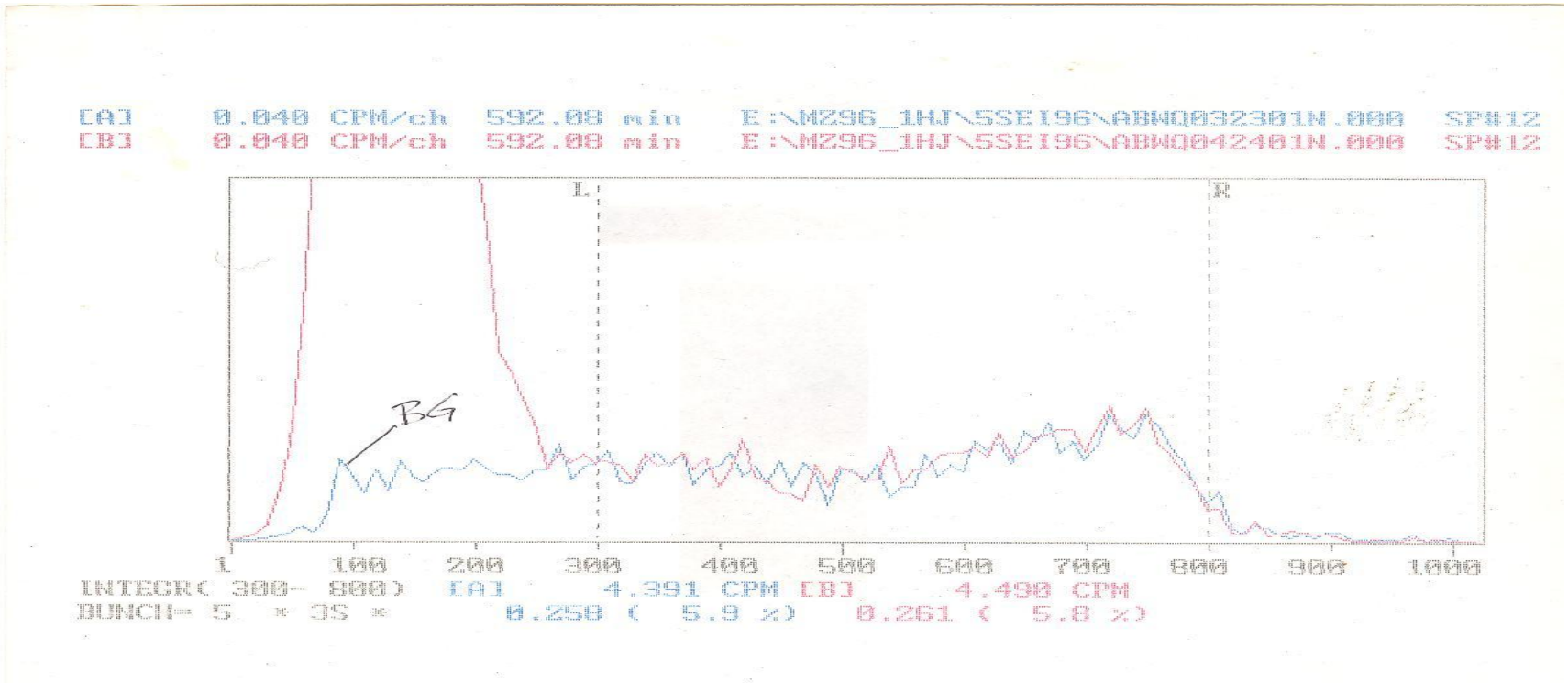
In the 50‘s and 60‘s of last century due to the excessive number of atmospheric nuclear weapons tests radioactivity of aerosols, fallout, water, food etc. had to be monitored. The sophisticated instrumentation we use nowadays in everyday routine did not exist and nuclide specific determinations had to be done by using time consuming and complicated chemical analytical methods and simple instruments. So called „gross“ measurements were used, but as soon, as even only a few radionuclides are present in a mixture they have to fail. Determination of doses will be impossible. There are no dose factors available for „gross alpha“ or „-beta“!!! A classification like „The activity is high“ or „it is low“ is not acceptable any more!

Not only excellent instrumentation has been developed, but there are also very fast and cheap modern radiochemical methods available like for instance ion exchange, chromatography and extraction with specially developed materials which are very widely spread and in use as state of the art. There is no need for „gross“-measurements any more. It is surprising that they experience a revival – especially in connection with LSC.

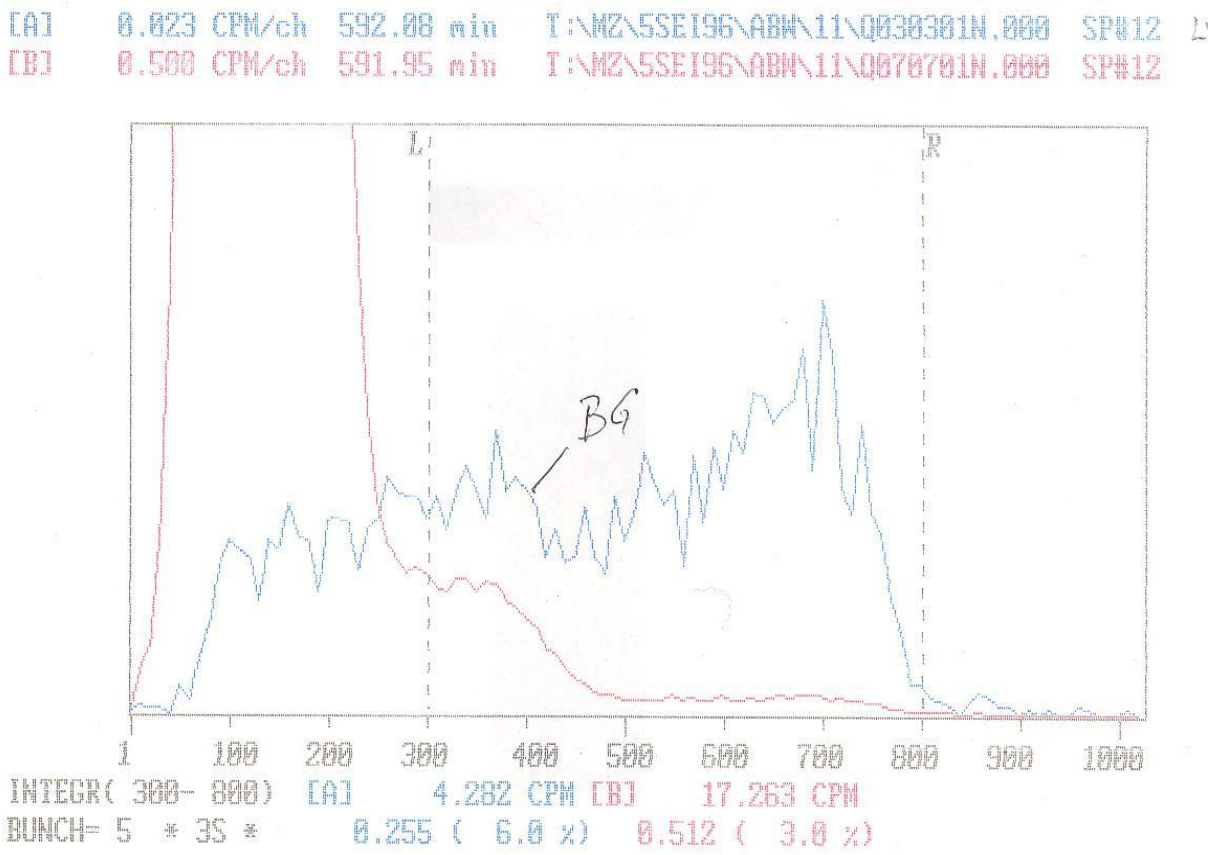
Bad experience with „gross“ measurements

Tritium discharge: undetected

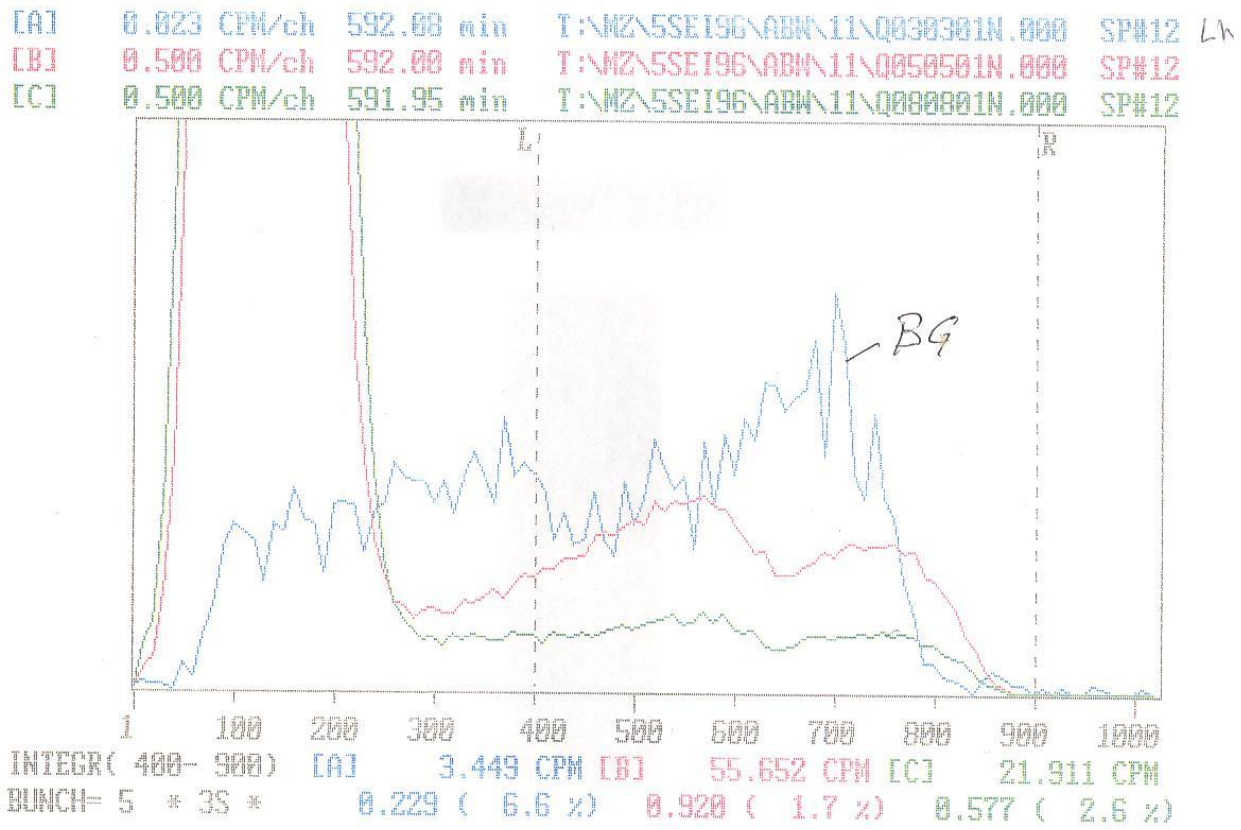
Two Austrian nuclear research institutes measured for decades their waste water by „gross alpha/beta after evaporation. Of course they never found out, that they were emitting large amounts of tritium, sometimes coming very close to the maximum permissible discharge.



Another sample of discharge



Sr-90 discharge: undetected



Uranium discharge: undetected

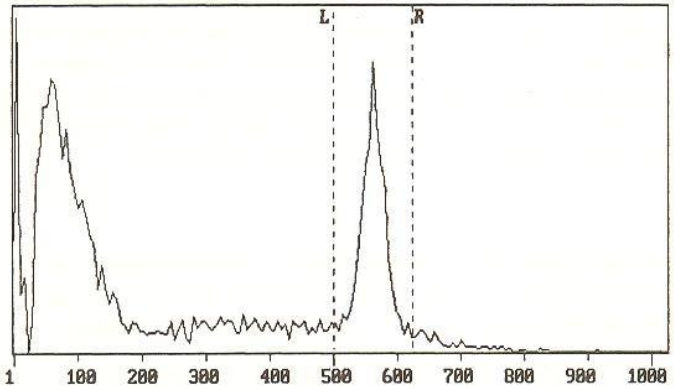


Fig. 1. Pulse-height spectrum of a wastewater sample

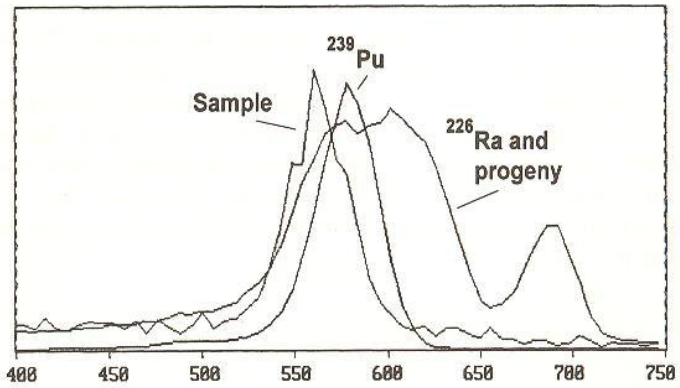
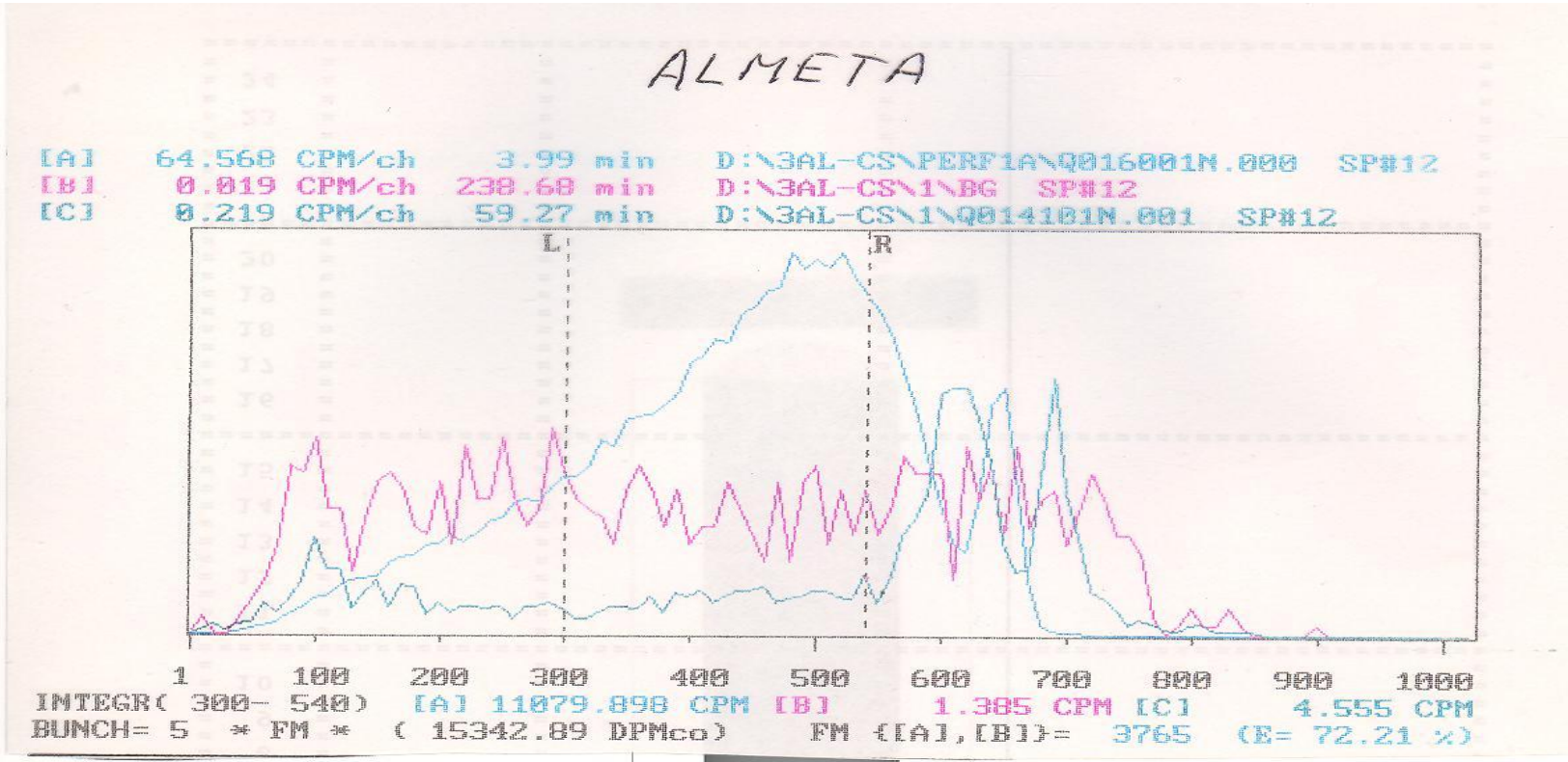


Fig. 2. Pulse-height spectra of the wastewater sample, a ^{239}Pu internal standard and a ^{226}Ra internal standard (pulse-height scale expanded)

Claim of heavy groundwater contamination by Cs-137

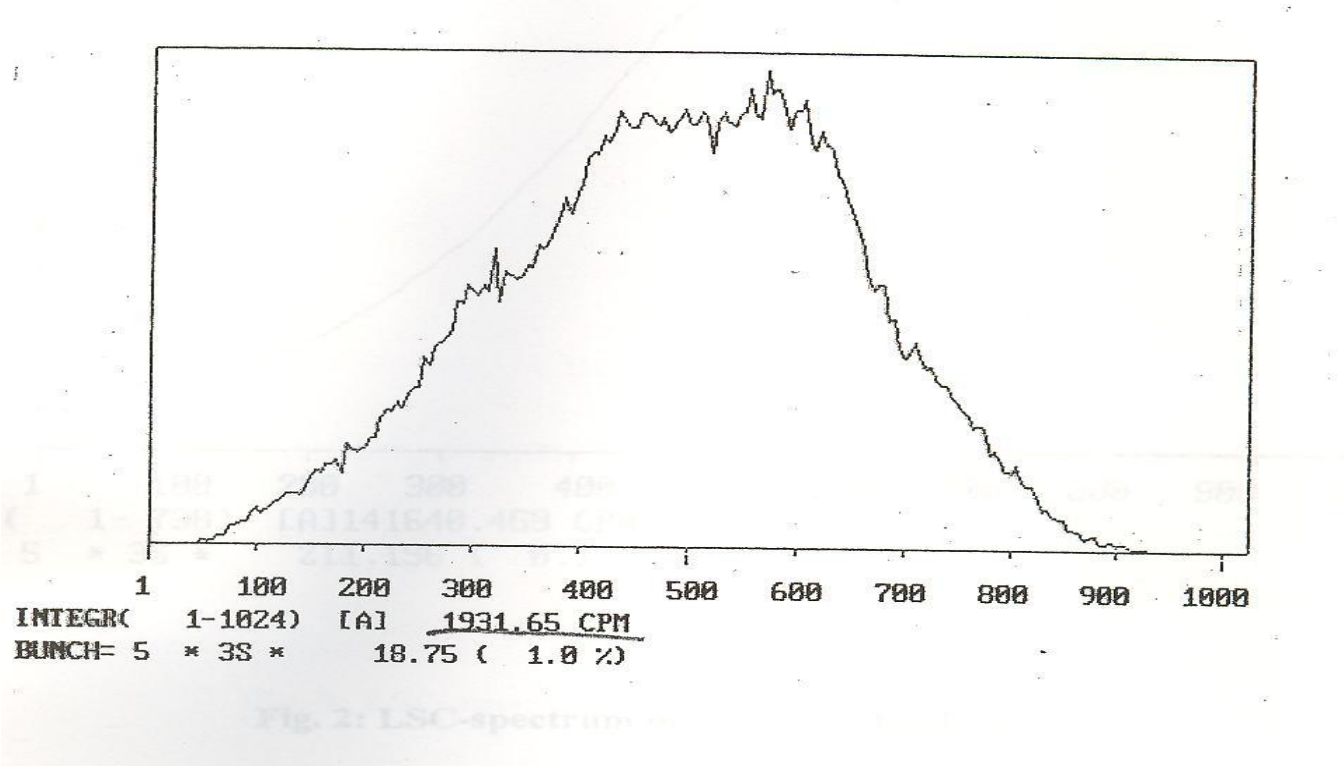
It became known, that aluminium scrap and slag had been sold to a scrapdealer, who stored it intermediately near Vienna. I was found that this scrap contained Cs-137 because of a source had been accidentally melted. Rumors were distributed that the groundwater had already been heavily contaminated. We had one afternoon and one night to verify this. While a collegue put a sample on the germanium detector over night I calibrated in the afternoon the LS counter for Cs-137 and had several different samples run over night. Needless to say that I was first with results for several samples, showing what was to be expected: radon.

- Cs-137 is a beta-emitter!!!



Fission products

- After the first news about the accident in Chernobyl we set out to the airport to check an aeroplane which came from Moskwa. We found some elevated gamma contamination of some parts, but this might have been due to natural radionuclides. When airplanes descend from usually 10 000 m to groundlevel ice forms due to the tremendous temperature difference on the wings. We collected some of the melting ice.

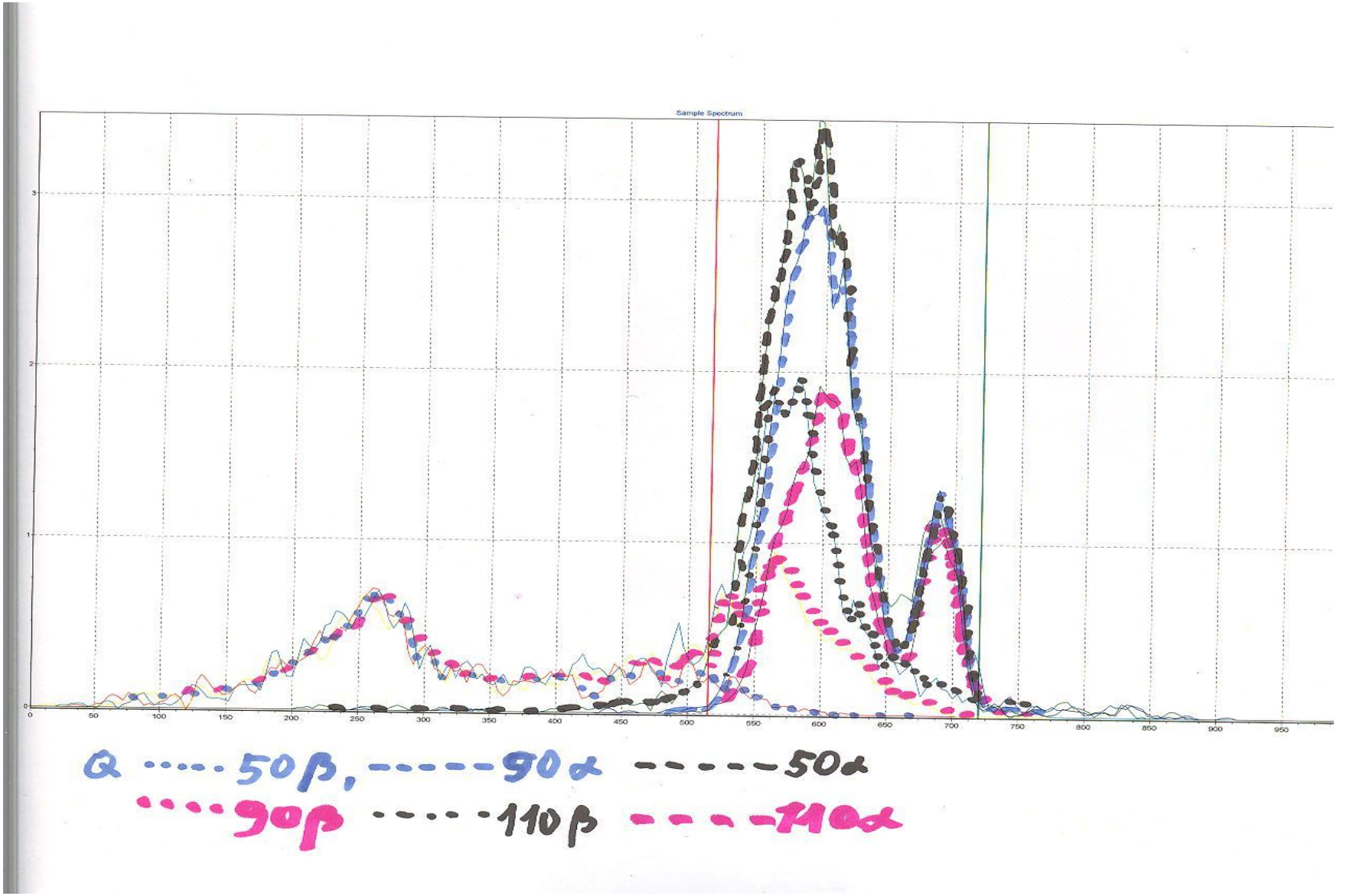


Alpha-beta separation

Depends heavily on: energies of alpha- and beta-emitters, cocktail, quench, type of vial etc. etc.

Example: Rn-222 in water, extracted into water immiscible cocktail (1:1), PTFE coated PE-vial, Quantulus, different PSA-levels:

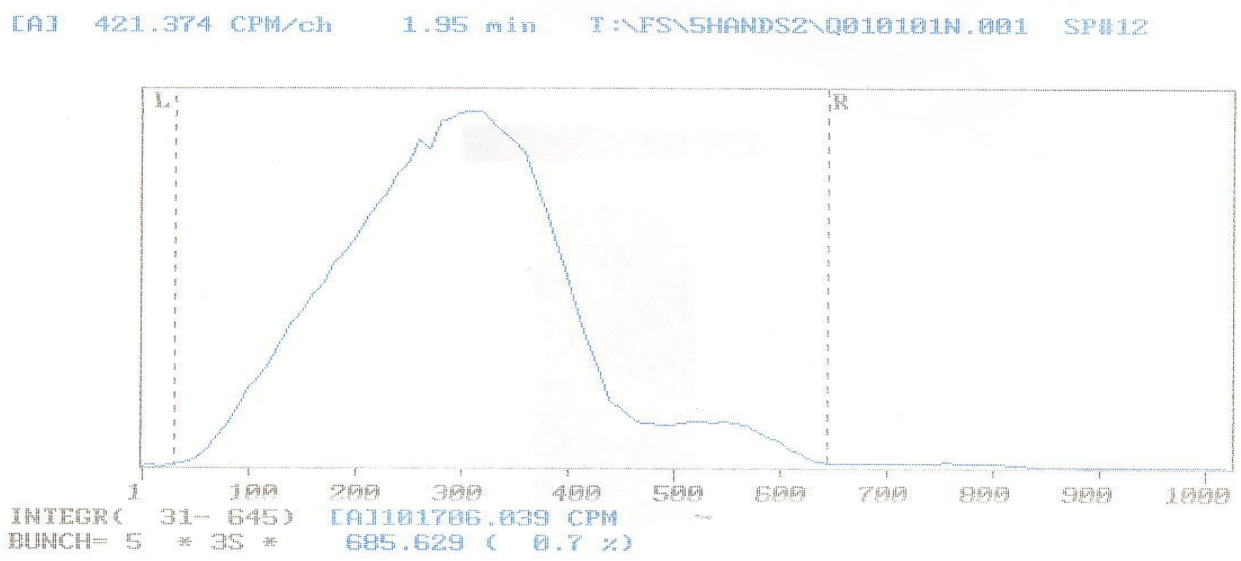
Influence of PSA on alpha-beta separation



Unknown contamination of a person

A person, who had worked in a radiochemical laboratory was found by a portal monitor to be contaminated by an unknown substance. Very fast it was verified, that the contamination was not due to any gamma-emitter. Alpha-emitters could be excluded as well.

A glove was found to be contaminated and we soaked it for about an hour in water. The resulting LSC-spectrum is shown below.



Discussion of conclusions

- In this paper it was shown, that „gross-alpha and gross-beta measurements“ deliver values, which have really nothing to do with the overall activity of both alpha or beta emitters.
- These measurememements are usually done in drinking water to verify compliance with regulations. Regulations are based on dose and I am still waiting (since many years) that somebody would enlighten me on the dose factors for gross-alpha and –beta.
- Even if (which is not the case!) an activity concentration of all beta emitters could be determined, there is no possibility to sort out radionuclides of extremely different dose factors (Tritium and Ra-228, not to talk about very high energetic beta emitters like Ac-228, Y-90 and many others).

Alternative to „gross something “

I showed in the few examples out of hundreds, that there is an alternative, which allows to extract with very simple procedures a maximum of information both qualitatively and quantitatively. First one has to gain some experience on LSC, collect information about possible contamination sources (natural radionuclides – nuclear – research...) then simply mix the liquid sample with a suitable cocktail, measure it and then carefully inspect the spectra visually. I believe that the success of this method has been demonstrated with striking results.

Costs

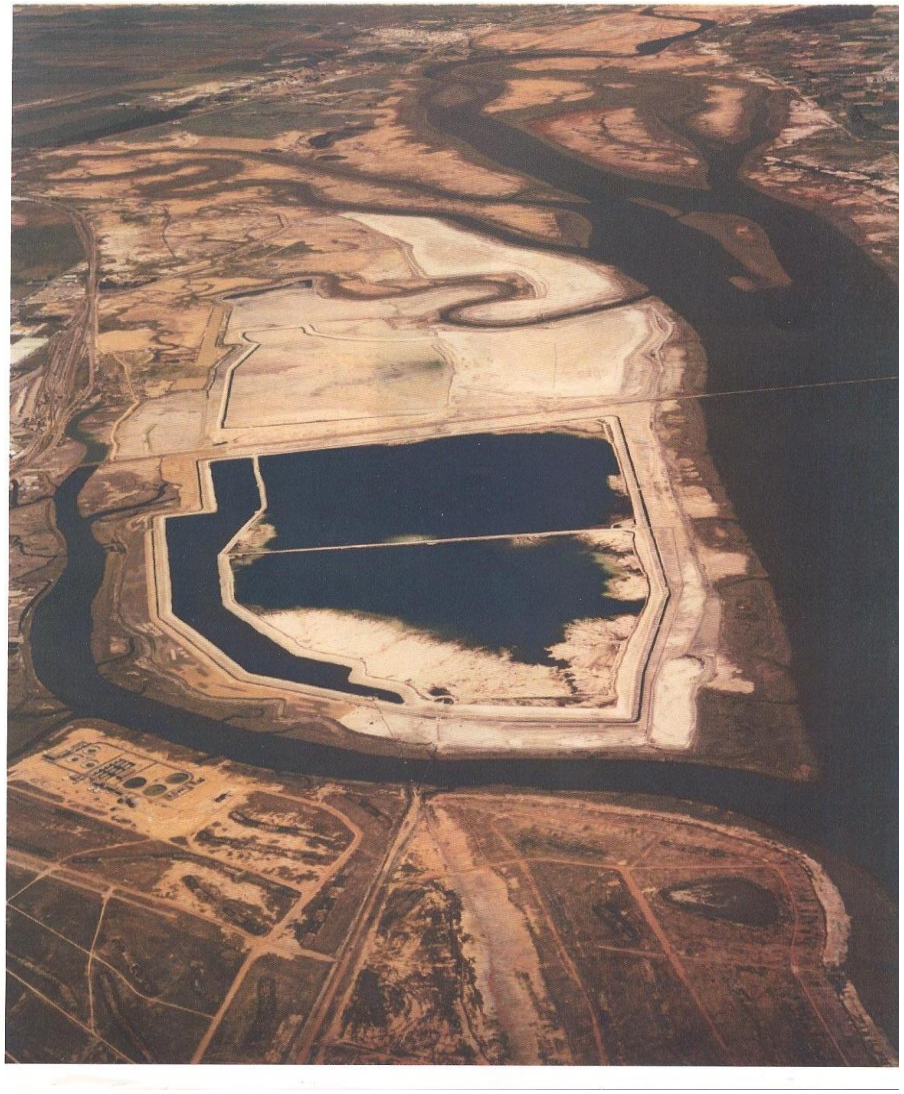
- One argument, often put forward in the discussions about „gross“ measurements is the claim, that equipment for nuclide specific measurements is to expensive and that also small laboratories with simple equipment should be able to do measurements. Why??? Each laboratory has to use the equipment which enables it to fulfil the criteria for analyses – if they can‘t they should not compete with those who can. If transport of a 20 ton marble block is requested one cannot offer transport when only a Volkswagen Beetle is available. As I have calculated the costs of analyses for instance for radon in air, it turned out that using the Quantulus and PICORAD vials resulted in a break even of the Quantulus costs and the financial benefit within the first two years of the project. The same is true for other analytical work.

- Chemicals for modern nuclidespecific analytical methods might be expensive, but time and money saved by not evaporating liters of waters and especially on (wo)man-power is enormous and has to be considered carefully.

- The sample preparation consists of pipetting two liquids into an LSC vial and mixing them by shaking.
- I admit that for evaluation an experienced person is necessary who is knowledgeable about likely or possibly present radionuclides. However this becomes routine after a while for similar samples and the expert will only be needed in complicated cases.

Work in progress

Last spring we started a project at the University of Sevilla (Spain) on a survey of NORM in bottled water marketed in Spain. Moreover we started LSC measurements on ground waters from the Huelva Gypsum Piles, with a large variation of different NORM radionuclides – uranium, Ra-226 and Ra-228 with all their progeny. Preliminary results are very encouraging.



Conclusions

In this paper it was shown, that „gross-alpha and gross-beta measurements“ deliver values, which have really nothing to do with the overall activity of both alpha or beta emitters. The „calibrations“ cannot be taken serious, because they are only applicable for mixtures of the two radionuclides used and how „standards“ can be produced is completely ununderstandable for me.

These measuremements are usually done on drinking water to verify compliance with regulations. Regulations are based on dose and I am still waiting (since many years) that somebody would enlighten me on the dose factors for gross-alpha and –beta.

Even if (which is not the case!) an activity concentration sum of all beta emitters could be determined, there is no possibility to sort out radionuclides of extremely different dose factors. Compare tritium and Ra-228, not to talk about very high energetic beta emitters like Ac-228, Y-90 and many others. Also among alpha emitters there are tremendous differences in radiotoxicity to be found. The effect of radionuclides like Rn-222, Po-210, U-238, Ra-226 differs by several orders of magnitude – how can this give even a rough estimate of the Total Indicative Dose?

Acknowledgements

- My thanks (FS) goes to several persons, who trusted me, that my retirement did not negatively affect my brain:
- First of all there is Stanislaw Chalupnik, who enabled me to work in the framework of a European Union Project five times at GIG in Katowice for several months each. I have to thank the staff of the Radiometria Laboratory for the manyfold help during my stay as well.
- Secondly my thanks go to Gabriele Wallner who was willing to take up some of my ideas and check and develop them further.
- Thirdly Rafael Garcia-Tenorio has enabled me to work last spring in Sevilla on determination of NORM in the Huelva gypsum piles and I will return there after this conference to continue this work.
- Not only those people have discussed with me the issue of „gross something“, but I found an increasing number of collegues, being partly extremely skeptical towards this method. It was psychologically important, not to feel alone with my heretic opinion....